REMARKS

The above amendments to the above-captioned application along with the following remarks are being submitted as a full and complete response to the Official Action dated November 20, 2003. In view of the above amendments and the following remarks, the Examiner is respectfully requested to give due reconsideration to this application, to indicate the allowability of the claims, and to pass this case to issue.

Status of the Claims

Claims 1, 2 and 4-14 are under consideration in this application. Claims 1, 4, 7 and 8 are being amended, as set forth in the above marked-up presentation of the claim amendments, in order to more particularly define and distinctly claim applicants' invention. New claims 10-14 are being added to recite other embodiments described in the specification.

Additional Amendments

The claims are being amended to correct formal errors and/or to better disclose or describe the features of the present invention as claimed. All the amendments to the claims are supported by the specification. Applicants hereby submit that no new matter is being introduced into the application through the submission of this response.

Prior Art Rejections

Claims 1-2, 4-6 and 9 were rejected under 35 U.S.C. § 103(a) on the grounds of being unpatentable over an article by Honda et al (IEEE Transactions on Magnetics, Vol. 36, No. 5, Sept. 2000; pp. 2399-2401; hereinafter "Honda") in view of US Pat. No. 6,120,890 to Chen et al. (hereinafter "Chen"). The Examiner also rejected claims 7-8 under 35 U.S.C. § 103(a) on the grounds of being unpatentable over Honda et al. (IEEE) in view of Chen et al. '890 in further view of US Pat. No. 6,001,447 to Tanahashi et al (hereinafter "Tanahashi"). These rejections have been carefully considered, but are most respectfully traversed.

The perpendicular magnetic recording medium according to the invention (e.g., Fig. 1), comprises: a substrate 11; a soft magnetic underlayer 13 formed on said substrate 11 and containing ferromagnetic α-Fe nanocrystals (p. 3, 3rd and 4th lines from the bottom; p. 6, last four lines); a nonmagnetic intermediate layer 14 formed on said soft magnetic underlayer 13; and a perpendicular recording layer 15 formed on said intermediate layer 14. A nonmagnetic amorphous or nanocrystalline pre-coating layer 12 is provided between said substrate 11 and said soft magnetic underlayer 13. (1) The soft magnetic underlayer 13 contains ferromagnetic α-Fe nanocrystals, Ta and C, and a concentration of said Ta ranges from 8 at % to 15 at % (Claim 1), or (2) contains ferromagnetic α-Fe nanocrystals and the in-plane coercivity Hc (298K) of said soft magnetic underlayer 13 is 1 Oe or less and in-plane coercivity Hc (173K) of said soft magnetic underlayer 13 is 3 Oe or more, the in-plane coercivity Hc (298K) being measured while applying magnetic field along a head running direction at a temperature of 298 K, and the in-plane coercivity Hc (173K) being measured while applying magnetic field along the head running direction at a temperature of 173 K (Claim 4).

The invention is also directed to a magnetic storage apparatus recited in claims 7-8 containing the perpendicular magnetic recording medium recited in claim 1 and claim 4 respectively.

The main feature of the invention is that a perpendicular magnetic recording medium has a laminated structure comprising: a substrate 11; an amorphous or nanocrystalline pre-coating layer 12; a soft magnetic underlayer 13; a nonmagnetic intermediate layer 14; and a perpendicular recording layer 15. The soft magnetic underlayer 13 (1) contains ferromagnetic α-Fe nanocrystals, Ta and C, and has a Ta concentration of from 8-15 at % (claim 1), or (2) contains ferromagnetic α-Fe nanocrystals and has in-plane coercivity Hc (298K) of 1 Oe or less and in-plane coercivity He (173K) of 3 Oe or more (claim 4).

According to the present invention, the soft magnetic underlayer 13 contains ferromagnetic α-Fe nanocrystals and is formed on the amorphous or nanocrystalline pre-coating layer 12 to suppress the nonuniformity of the soft magnetic underlayer 13 attributable to a type of substrate material or temperature distribution in annealing. Therefore, the invention can provide a perpendicular magnetic recording medium which sufficiently reduces medium noises attributable to the soft magnetic underlayer 13 (see page 4, lines 4 to 8).

Applicants respectfully contend that neither Honda nor any other cited prior art reference teaches or suggests such a laminated structure of a perpendicular magnetic recording medium.

In contrast, the soft magnetic underlayer containing Fe, Ta and C in Honda is directly formed on a glass substrate, rather than having an amorphous or nanocrystalline pre-coating layer 12 formed therebetween. As admitted by the Examiner, Honda fails to teach an amorphous or nanocrystalline pre-coating layer formed between the substrate and the soft magnetic underlayer. Honda also fails to teach that its soft magnetic underlayer contains ferromagnetic α-Fe nanocrystals.

The NiP sealing layer 21of Chen was relied upon by the Examiner to teach an amorphous or nanocrystalline pre-coating layer formed between the substrate and the soft magnetic underlayer. Chen (Fig. 2; col. 6, lines 41-48) discloses a magnetic recording medium having a laminated structure comprising: a substrate 20; a NiP sealing layer 21; an underlayer 22; and a magnetic layer 23 (in-plane or perpendicular). Chen's underlayer 22 (arguably equivalent to the soft magnetic underlayer 13) "*comprises Cr or an alloy thereof, such as CrV* (col. 6, lines 49-50)," rather than any ferromagnetic α-Fe nanocrystals. As such, Chen still fails to compensate for Honda's deficiencies.

Secondly, none of the cited references teaches or suggests "providing a soft magnetic underlayer with ferromagnetic α-Fe nanocrystals by annealing (as recited in new claims 10-13)." In contrast, Honda deposits "*soft magnetic underlayers of 440 nm thickness on grass substrates at room temperature* (p. 2399, left col. last paragraph, lines 4-6)". Chen's underlayer 22 is also deposited on the amorphous sealing layer 21 (col. 5, line 58), rather than being annealed in a high-temperature treatment of 450-500° (p. 6, last four lines) to provide ferromagnetic α-Fe nanocrystals therein according to the invention.

Thirdly, the combination of Chen's NiP sealing layer 21 with Honda's substrate and Fe-Ta-C soft magnetic underlayer would crystallize and magnetize Ni in Chen's NiP sealing layer 21 such that Chen's NiP sealing layer could not maintain its amorphous or nanocrystalline state. As such, the intended purpose of inserting Chen's NiP sealing layer 21 would be totally destroyed in the combination. Applicants contend that one skilled in the art will not be motivated to combine the teachings in Honda and Chen in the manner suggested by the Examiner since the resulting physical change of Chen's NiP sealing layer 21will contradict its intended purpose.

Honda's Fe-Ta-C soft magnetic underlayer is deposited on a glass substrate then "*treated*

with heat at 450° to get high saturation magnetization" (p. 2399, left col. last paragraph, lines 6-7). Since Chen's NiP sealing layer is allegedly deposited on Honda's substrate then being deposited thereon the Honda's Fe-Ta-C soft magnetic underlayer. Chen's NiP sealing layer would be inevitably heat-treated along with Honda's Fe-Ta-C soft magnetic underlayer such that crystallization and phase separation of Ni would take place, resulting in Ni being magnetized (see the underlined portions of the attached paper, where is noted that heating of amorphous NiP to approximately 360° results in crystallization).

On the other hand, in the present invention, the amorphous or nanocrystalline pre-coating layer 12 is capable of maintaining its amorphous state and nonmagnetic even after a high-temperature annealing treatment for obtaining a soft magnetic underlayer 13 containing ferromagnetic α-Fe nanocrystals. "*A ratio of the Ta concentration to the C concentration (Ta concentration/C concentration) should be set to a range from 0.5 to 0.9. It is possible to precipitate the ferromagnetic α-Fe nanocrystals uniformly by preferably annealing the material of the soft magnetic underlayer after setting the Ta concentration and the ratio of the Ta concentration to the C concentration (Ta concentration/C concentration) to the above described ranges. If the ratio of the Ta concentration to the C concentration is out of the above described range, separations of α-Fe and TaC by annealing are insufficient, and the soft magnetic properties are undesirably deteriorated* (p. 3, last paragraph)." Thus, the soft magnetic underlayer 13, which is formed on the amorphous or nanocrystalline pre-coating layer 12, is prevented from magnetic nonuniformity thereby significantly reducing media noise according to the invention (p. 3, lines 13-15).

Applicants contend that neither Honda nor Chen teaches or discloses each and every feature of the present invention as disclosed in at least independent claims 1, 4, 7 and 8. As such, the present invention as now claimed is distinguishable and thereby allowable over the rejections raised in the Office Action. The withdrawal of the outstanding prior art rejections is in order, and is respectfully solicited.

In view of all the above, clear and distinct differences as discussed exist between the present invention as now claimed and the prior art reference upon which the rejections in the Office Action rely, Applicants respectfully contend that the prior art references cannot anticipate the present invention or render the present invention obvious. Rather, the present invention as a whole is distinguishable, and thereby allowable over the prior art.

Favorable reconsideration of this application is respectfully solicited. Should there be any outstanding issues requiring discussion that would further the prosecution and allowance of the above-captioned application, the Examiner is invited to contact the Applicants' undersigned representative at the address and phone number indicated below.

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